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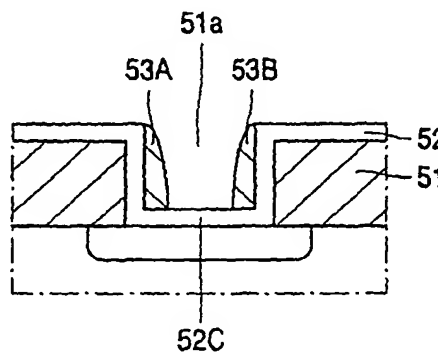
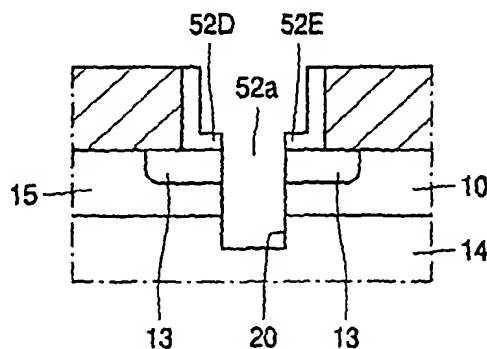
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For two-letter codes and other abbreviations, refer to the "Guid-
ance Notes on Codes and Abbreviations" appearing at the begin-
ning of each regular issue of the PCT Gazette.

(54) Title: METHOD OF MANUFACTURING A TRENCH-GATE SEMICONDUCTOR DEVICE AND CORRESPONDING DE-
VICE



(57) Abstract: The manufacture of a trench-gate semiconductor device, for example a power transistor or a memory device includes the steps of forming at a surface (10a) of a semiconductor body (10) a first mask (51) having a first window (51a), providing a thin layer of a second material (52) in the first window (51a), forming an intermediate mask (53A, 53B) of a third material having curved sidewalls and using the intermediate mask (53A, 53B) to form two L-shaped parts (52A, 52D and 52B, 52E) of the second material with a second window (52a) which is used to etch a trench-gate trench (20). The rectangular base portion (52D, 52E) of each L-shaped part ensures that the trench (20) is maintained narrow during etching. Narrow trenches are advantageous for low specific on-resistance and low RC delay in low voltage cellular trench-gate power transistors. Narrow deep trenches are also advantageous for cell density in DRAM devices where a memory cell has a switching transistor cell surrounded by a trench-gate and a storage capacitor in a lower part of the same trench.

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INTERNATIONAL SEARCH REPORT

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A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 H01L21/336 H01L21/331 H01L21/8242 H01L21/338 H01L21/308
H01L29/78 H01L29/739 H01L27/108 H01L29/812

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 H01L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the International search (name of data base and, where practical, search terms used)

WPI Data, PAJ, INSPEC, COMPENDEX, IBM-TDB, EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	NAM K S ET AL: "A novel simplified process for fabricating a very high density p-channel trench gate power MOSFET" IEEE ELECTRON DEVICE LETTERS, vol. 21, no. 7, July 2000 (2000-07), pages 365-367, XP000951986 IEEE, NEW YORK, NY, USA ISSN: 0741-3106	16-19
A	paragraphs II, III; figure 1	1-4,6
X	WO 99 54918 A (KONINKLIJKE PHILIPS ELECTRONICS NV ET AL) 28 October 1999 (1999-10-28) cited in the application	16-19
A	page 7, line 14 -page 10, line 31; figures 1-9 --- -/-	1-4,6,7



Further documents are listed in the continuation of box C.



Patent family members are listed in annex.

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 177 576 A (KIMURA S ET AL) 5 January 1993 (1993-01-05)	20
A	column 5, line 27 -column 8, line 37; figures 6A-6V ---	1,2,15
A	KAGA T ET AL: "Advanced OSELO isolation with shallow grooves for high-speed submicrometer ULSIs" IEEE TRANSACTIONS ON ELECTRON DEVICES, vol. 35, no. 7, July 1988 (1988-07), pages 893-898, XP002198976 IEEE, NEW YORK, NY, USA ISSN: 0018-9383 page 893, lines 1-13 of paragraph II; figure 3 -----	1,2,4

INTERNATIONAL SEARCH REPORT

Information on patent family members

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Patent document cited in search report		Publication date	Patent family member(s)	Publication date
WO 9954918	A	28-10-1999	EP 0996969 A2	03-05-2000
			WO 9954918 A2	28-10-1999
			JP 2002505810 T	19-02-2002
			US 6087224 A	11-07-2000
US 5177576	A	05-01-1993	JP 4014868 A	20-01-1992